

125 GeV Higgs-Boson as Scalar partner of 91 GeV Z^0 -Weak-boson in Composite subquark model

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Abstract

The composite subquark model previously proposed by us shows that the intermediate Z^0 -weak-boson is realized as the composite particle and that its scalar partner has the mass value larger than Z^0 -weak-boson mass. It is suggested that 125 GeV Higgs-boson found at LHC is a scalar partner of 91 GeV Z^0 -weak-boson. We predict the existence of charged Higgs-bosons with the mass value around 100 to 120 GeV as the scalar partners of W^\pm . We also discuss about Dark energy and Dark matter.

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1 Introduction

Previously we predicted that the Higgs-boson mass would be around 110 to 120 GeV[1] in our composite subquark model[2], which naturally leads us to the thought that the intermediate vector bosons of weak interactions (W, Z) are not elementary gauge fields but “*composite particles*” constructed of subquarks[1][2].

In hadron physics the hyperfine spin-spin interactions in Breit-Fermi Hamiltonian explain ρ - π, K^*-K , (etc.) mass-splittings[14].

In our composite subquark model W and Z have the scalar partners by the same mechanism of the hyperfine spin-spin interactions as that in hadron physics. But our model find that the scalar partners have “*larger masses*” than W and Z masses contrary to hadron physics.

We argue that 125 GeV Higgs-boson founded at LHC may be the scalar partner of 91 GeV Z -boson. If our composite scenario is true, we may suggest that the scalar partners of W -bosons are founded around 100 to 120 GeV energy regions.

In section 2 we explain the gauge theory inspiring the composite scenario. In section 3 the contents of the composite subquark model is investigated. In section 4 we explain the possibility that 125 GeV Higgs-boson is the scalar partner of 91 GeV Z -boson.

2 Gauge theory inspiring composite scenario

In our model the existence of fundamental matter fields (preon) are inspired by the gauge theory with Cartan connections[2]. Let us briefly summarize the basic features of that. Generally gauge fields, including gravity, are considered as geometrical objects, that is, connection coefficients of principal fiber bundles. It is said that there exist some different points between Yang-Mills gauge theories and gravity, though both theories commonly possess fiber bundle structures. The latter has the fiber bundle related essentially to 4-dimensional space-time freedoms but the former is given, in an ad hoc way, the one with the internal space which has nothing to do with the space-time coordinates. In case of gravity it is usually considered that there exist ten gauge fields, that is, six spin connection fields in $SO(1, 3)$ gauge group and four vierbein fields in $GL(4, R)$ gauge group from which the metric tensor $g^{\mu\nu}$ is constructed in a bilinear function of them. Both altogether belong to Poincaré group $ISO(1, 3) = SO(1, 3) \otimes R^4$ which is semi-direct product. In this scheme spin connection fields and vierbein fields

are independent but only if there is no torsion, both come to have some relationship. Seeing this, $ISO(1,3)$ gauge group theory has the logical weak point not to answer how two kinds of gravity fields are related to each other intrinsically.

In the theory of Differential Geometry, S.Kobayashi has investigated the theory of “Cartan connection”[15]. This theory, in fact, has ability to reinforce the above weak point. The brief recapitulation is as follows. Let $E(B_n, F, G, P)$ be a fiber bundle (which we call Cartan-type bundle) associated with a principal fiber bundle $P(B_n, G)$ where B_n is a base manifold with dimension “ n ”, G is a structure group, F is a fiber space which is homogeneous and diffeomorphic with G/G' where G' is a subgroup of G . Let $P' = P'(B_n, G')$ be a principal fiber bundle, then P' is a subbundle of P . Here let it be possible to decompose the Lie algebra \mathfrak{g} of G into the subalgebra \mathfrak{g}' of G' and a vector space \mathfrak{f} such as :

$$\mathfrak{g} = \mathfrak{g}' + \mathfrak{f}, \quad \mathfrak{g}' \cap \mathfrak{f} = 0, \quad (1)$$

$$[\mathfrak{g}', \mathfrak{g}'] \subset \mathfrak{g}', \quad (2)$$

$$[\mathfrak{g}', \mathfrak{f}] \subset \mathfrak{f}, \quad (3)$$

$$[\mathfrak{f}, \mathfrak{f}] \subset \mathfrak{g}', \quad (4)$$

where $\dim \mathfrak{f} = \dim F = \dim G - \dim G' = \dim B_n = n$. The homogeneous space $F = G/G'$ is said to be “weakly reductive” if there exists a vector space \mathfrak{f} satisfying Eq.(1) and (3). Further F satisfying Eq(4) is called “symmetric space”. Let ω denote the connection form of P and $\overline{\omega}$ be the restriction of ω to P' . Then $\overline{\omega}$ is a \mathfrak{g} -valued linear differential 1-form and we have :

$$\omega = g^{-1}\overline{\omega}g + g^{-1}dg, \quad (5)$$

where $g \in G$, $dg \in T_g(G)$. ω is called the form of “Cartan connection” in P .

Let the homogeneous space $F = G/G'$ be weakly reductive. The tangent space $T_O(F)$ at $o \in F$ is isomorphic with \mathfrak{f} and then $T_O(F)$ can be identified with \mathfrak{f} and also there exists a linear \mathfrak{f} -valued differential 1-form(denoted by θ) which we call the “form of soldering”. Let ω' denote a \mathfrak{g}' -valued 1-form in P' , we have :

$$\overline{\omega} = \omega' + \theta. \quad (6)$$

The dimension of vector space \mathbf{f} and the dimension of base manifold B_n is the same “ n ”, and then \mathbf{f} can be identified with the tangent space of B_n at the same point in B_n and θ s work as n -bein fields. In this case ω' and θ unifyingly belong to group G . Here let us call such a mechanism “Soldering Mechanism”.

Drechsler has found out the useful aspects of this theory and investigated a gravitational gauge theory based on the concept of the Cartan-type bundle equipped with the Soldering Mechanism[16]. He considered $F = SO(1, 4)/SO(1, 3)$ model. Homogeneous space F with $\dim = 4$ solders 4-dimensional real space-time. The Lie algebra of $SO(1, 4)$ corresponds to \mathbf{g} in Eq.(1), that of $SO(1, 3)$ corresponds to \mathbf{g}' and \mathbf{f} is 4-dimensional vector space. The 6-dimensional spin connection fields are \mathbf{g}' -valued objects and vierbein fields are \mathbf{f} -valued, both of which are unified into the members of $SO(1, 4)$ gauge group. We can make the metric tensor $\mathbf{g}^{\mu\nu}$ as a bilinear function of \mathbf{f} -valued vierbein fields. Inheriting Drechsler’s study the author has investigated the quantum theory of gravity[2]. The key point for this purpose is that F is a symmetric space because \mathbf{f} s are satisfied with Eq.(4). Using this symmetric nature we can pursue making a quantum gauge theory, that is, constructing \mathbf{g}' -valued Faddeev-Popov ghost(denoted by \mathbf{C}), anti-ghost (denoted by $\overline{\mathbf{C}}$), gauge fixing(denoted by \mathbf{B}), anti-gaugefixing(denoted by $\overline{\mathbf{B}}$)gaugeon (denoted by \mathbf{G}_1) and its pair field(denoted by \mathbf{G}_2) as composite fusion fields of \mathbf{f} -valued gauge fields “ θ ” by use of Eq.(4) and also naturally inducing BRS-invariance among them. In this way these six kinds of fusion fields are made of \mathbf{f} -valued vierbein fields.

Here let us call these six fields together “**six-fields-set**”: $\{ \mathbf{C}, \overline{\mathbf{C}}, \mathbf{B}, \overline{\mathbf{B}}, \mathbf{G}_1, \mathbf{G}_2 \}$. They are not mathematical tools for BRS-invariance but “**Real Fiels**” existing at every points of the universe.

Comparing such a scheme of gravity, let us consider Yang-Mills gauge theories. Usually when we make the Lagrangian density $\mathcal{L} = \text{tr}(\mathcal{F} \wedge \mathcal{F}^*)$ (\mathcal{F} is a field strength), we must borrow a metric tensor $\mathbf{g}^{\mu\nu}$ from gravity to get \mathcal{F}^* and also for Yang-Mills gauge fields to propagate in the 4-dimensional real space-time. This seems to mean that “there is a hierarchy between gravity and other three gauge fields (electromagnetic, strong, and weak)”. But is it really the case? As an alternative thought we can think that all kinds of gauge fields are “equal”. Then it would be natural for the question “What kind of equality is that?” to arise. In other words, it is the question that “What is the minimum structure of the gauge mechanism which four kinds of forces are commonly equipped with?”. For answering this question, let us make a assumption : “*Gauge fields are Cartan connections equipped with Soldering Mechanism.*” In this

meaning all gauge fields are equal. If it is the case three gauge fields except gravity are also able to have their own metric tensors “ $\mathbf{g}_a^{\mu\nu}$ ” (where a means *electromagnetic*, *strong* and *weak*.) and to propagate in the real space-time without the help of gravity. Such a model has already investigated in ref.[2].

Let us discuss them briefly. It is found that there are four types of sets of classical groups with small dimensions which admit Eq.(1,2,3,4), that is, $F = SO(1, 4)/SO(1, 3)$, $SU(3)/U(2)$, $SL(2, C)/GL(1, C)$ and $SO(5)/SO(4)$ with $\dim F = 4$ [17]. Note that the quality of “ $\dim 4$ ” is very important because it guarantees F to solder to 4-dimensional real space-time and all gauge fields to work in it. The model of $F = SO(1, 4)/SO(1, 3)$ for gravity is already mentioned. Concerning other gauge fields, it seems to be appropriate to assign $F = SU(3)/U(2)$ to QCD gauge fields, $F = SL(2, C)/GL(1, C)$ to QED gauge fields and $F = SO(5)/SO(4)$ to weak interacting gauge fields (as is well known, $SO(4)$ is locally isomorphic with $SU(2) \otimes SU(2)$, which we set as $SU(2)_L \otimes SU(2)_R$). It is noted that four kinds of \mathbf{g}' -valued gauge fields have each **six-fields-set** of their own and with the help of **six-fields-set** and also with $\mathbf{g}_i^{\mu\nu}$ ($i = \textit{gravitational, electromagnetic, strong, and weak}$) they can propagate all over the universe.

And also it is memorable that our model expects that the **six-fields-set** may really exist at “ every point of the universe ”. Then “ **massless fermionic scalar fields** ” such as $\{\mathbf{C}, \overline{\mathbf{C}}\}$ cause the “ **repulsive forces** ” at every points of the universe which lead to the expanding universe. Especially at the **very early universe** they may be thought to have generated the **huge repulsive force** by **Pauli Exclusion Principle**. Therefore the **Six-Fields-Sets** of all gauge fields are possibly candidates for “**Dark Energy**”.

. Some discussions concerned are following. In general, matter fields couple to \mathbf{g}' -valued gauge fields. As for QCD, matter fields couple to the gauge fields of $U(2)$ subgroup but $SU(3)$ contains, as is well known, three types of $SU(2)$ subgroups and then after all they couple to all members of $SU(3)$ gauge fields. In case of QED, $GL(1, C)$ is locally isomorphic with $C^1 \cong U(1) \otimes R$. Then usual Abelian gauge fields are assigned to $U(1)$ subgroup of $GL(1, C)$. Georgi and Glashow suggested that the reason why the electric charge is quantized comes from the fact that $U(1)$ electromagnetic gauge group is a unfactorized subgroup of $SU(5)$ [18]. Our model is in the same situation because $GL(1, C)$ a unfactorized subgroup of $SL(2, C)$. For usual electromagnetic $U(1)$ gauge group, the electric charge unit “ e ” ($e > 0$) is for *one generator* of $U(1)$ but in case of $SL(2, C)$ which has *six generators*, the minimal unit of electric charge shared

per one generator must be “ $e/6$ ”. This suggests that quarks and leptons might have the substructure simply because $e, 2e/3, e/3 > e/6$. Finally as for weak interactions we adopt $F = SO(5)/SO(4)$. It is well known that $SO(4)$ is locally isomorphic with $SU(2) \otimes SU(2)$. Therefore it is reasonable to think it the left-right symmetric gauge group : $SU(2)_L \otimes SU(2)_R$. As two $SU(2)$ s are direct product, it is able to have coupling constants ($\mathbf{g}_L, \mathbf{g}_R$) independently. This is convenient to explain the fact of the disappearance of right-handed weak interactions in the low-energy region. Possibility of composite structure of quarks and leptons suggested by above $SL(2, C)$ -QED would introduce the thought that the usual left-handed weak interactions are intermediated by massive composite vector bosons as ρ -meson in QCD and that they are residual interactions due to substructure dynamics of quarks and leptons. The elementary massless gauge fields , “ *as connection fields*”, relate intrinsically to the structure of the real space-time manifold but on the other hand the composite vector bosons have nothing to do with it. Considering these discussions, we set the assumption : “*All kinds of gauge fields are elementary massless fields, belonging to spontaneously unbroken $SU(3)_C \otimes SU(2)_L \otimes SU(2)_R \otimes U(1)_{e.m}$ gauge group and quarks and leptons and \mathbf{W}, \mathbf{Z} are all composite objects of the elementary matter fields.*”

3 Composite model

Our direct motivation towards compositeness of quarks and leptons is one of the results of the arguments in Section.2, that is, $e, 2e/3, e/3 > e/6$. However, other several phenomenological facts tempt us to consider a composite model, e.g., repetition of generations, quark-lepton parallelism of weak isospin doublet structure, quark-flavor-mixings, etc.. Especially Bjorken[3]’s and Hung and Sakurai[4]’s suggestion of an alternative to unified weak-electromagnetic gauge theories have invoked many studies of composite models including composite weak bosons[5-11]. Our model is in the line of those studies. There are two ways to make composite models, that is, “Preons are all fermions.” or “Preons are both fermions and bosons (denoted by FB-model).” The merit of the former is that it can avoid the problem of a quadratically divergent self-mass of elementary scalar fields. However, even in the latter case such a disease is overcome if both fermions and bosons are the supersymmetric pairs, both of which carry the same quantum numbers except the nature of Lorentz transformation (spin-1/2 or spin-0)[19]. Pati and Salam have suggested that the construction of a neutral composite object (neutrino in practice) needs both kinds of preons, fermionic as well as

bosonic, if they carry the same charge for the Abelian gauge or belong to the same (fundamental) representation for the non-Abelian gauge[20]. This is a very attractive idea for constructing the minimal model. Further, according to the representation theory of Poincaré group both integer and half-integer spin angular momentum occur equally for massless particles[21], and then if nature chooses “fermionic monism”, there must exist the additional special reason to select it. Therefore in this point also, the thought of the FB-model is minimal. Based on such considerations we propose a FB-model of “only one kind of spin-1/2 elementary field (denoted by Λ) and of spin-0 elementary field (denoted by Θ)” (preliminary version of this model has appeared in Ref.[2]). Both have the same electric charge of “ $e/6$ ” (Maki has first proposed the FB-model with the minimal electric charge $e/6$. [22])¹ and the same transformation properties of the fundamental representation (3, 2, 2) under the spontaneously unbroken gauge symmetry of $SU(3)_C \otimes SU(2)_L \otimes SU(2)_R$ (let us call $SU(2)_L \otimes SU(2)_R$ “hypercolor gauge symmetry”). Then Λ and Θ come into the supersymmetric pair which guarantees ’tHooft’s naturalness condition[23]. The $SU(3)_C$, $SU(2)_L$ and $SU(2)_R$ gauge fields cause the confining forces with confining energy scales of $\Lambda_c \ll \Lambda_L < (or \cong) \Lambda_R$ (Schrempp and Schrempp discussed this issue elaborately in Ref.[11]). Here we call positive-charged primons (Λ , Θ) “matter” and negative-charged primons ($\bar{\Lambda}$, $\bar{\Theta}$) “antimatter”. Our final goal is to build quarks, leptons and \mathbf{W}, \mathbf{Z} from Λ ($\bar{\Lambda}$) and Θ ($\bar{\Theta}$). Let us discuss that scenario next.

At the very early stage of the development of the universe, the matter fields (Λ , Θ) and their antimatter fields ($\bar{\Lambda}$, $\bar{\Theta}$) must have broken out from the vacuum. After that they would have combined with each other as the universe was expanding. That would be the first step of the existence of composite matters. There are ten types of them :

$spin \frac{1}{2}$	$spin 0$	$e.m. charge$	$Y.M. representation$
$\Lambda\Theta$	$\Lambda\Lambda, \Theta\Theta$	$\frac{1}{3}e$	$(\bar{3}, 1, 1) (\bar{3}, 3, 1) (\bar{3}, 1, 3),$ (7a)
$\Lambda\bar{\Theta}, \bar{\Lambda}\Theta$	$\Lambda\bar{\Lambda}, \Theta\bar{\Theta}$	0	$(1, 1, 1) (1, 3, 1) (1, 1, 3),$ (7b)
$\bar{\Lambda}\bar{\Theta}$	$\bar{\Lambda}\bar{\Lambda}, \bar{\Theta}\bar{\Theta}$	$-\frac{1}{3}e$	$(3, 1, 1) (3, 3, 1) (3, 1, 3).$ (7c)

In this step the confining forces are, in kind, in $SU(3) \otimes SU(2)_L \otimes SU(2)_R$ gauge symmetry but the $SU(2)_L \otimes SU(2)_R$ confining forces must be main because of the energy scale of $\Lambda_L, \Lambda_R \gg \Lambda_c$ and then the color gauge coupling α_s and e.m. coupling

¹The notations of Λ and Θ are inherited from those in Ref.[22]. After this we call Λ and Θ “Primon” named by Maki which means “primordial particle”[22].

constant α are negligible. As is well known, the coupling constant of $SU(2)$ confining force are characterized by $\varepsilon_i = \sum_a \sigma_p^a \sigma_q^a$, where σ s are 2×2 matrices of $SU(2)$, $a = 1, 2, 3$, $p, q = \Lambda, \bar{\Lambda}, \Theta, \bar{\Theta}$, $i = 0$ for singlet and $i = 3$ for triplet. They are calculated as $\varepsilon_0 = -3/4$ which causes the attractive force and $\varepsilon_3 = 1/4$ causing the repulsive force. Next, $SU(3)_C$ octet and sextet states are repulsive but singlet, triplet and antitriplet states are attractive and then the formers are disregarded. Like this, two primons are confined into composite objects in more than one singlet state of any $SU(3)_C, SU(2)_L, SU(2)_R$. Note that three primon systems cannot make the singlet states of $SU(2)$. Then we omit them.

In Eq.(7b), the $(1, 1, 1)$ -state is the “most attractive channel”. Therefore $(\Lambda\bar{\Theta})$, $(\bar{\Lambda}\Theta)$, $(\Lambda\bar{\Lambda})$ and $(\Theta\bar{\Theta})$ of $(1, 1, 1)$ -states with neutral e.m.charge must have been **most abundant** in the universe. Further $(\bar{3}, 1, 1)$ - and $(3, 1, 1)$ -states in Eq.(7a,c) are next attractive. They presumably go into $\{(\Lambda\Theta)(\bar{\Lambda}\bar{\Theta})\}, \{(\Lambda\Lambda)(\bar{\Lambda}\bar{\Lambda})\}$, etc. of $(1, 1, 1)$ -states with neutral e.m.charge. These objects may be the candidates for the “**Cold Dark Matters**”. Therefore it may be said that “**Dark Matter is the neutral two primon system.**” It is presumable that the ratio of the quantities between the ordinary matters and the dark matters firstly depends on the color and hypercolor charges and the quantity of the latter much exesses that of the former (maybe the ratio is more than $1/(2 \times 3)$).

Finally the $(*, 3, 1)$ -and $(*, 1, 3)$ -states are remained ($*$ is $1, 3, \bar{3}$). They are also stable because $|\varepsilon_0| > |\varepsilon_3|$. They are, so to say, the “**intermediate clusters**” towards constructing ordinary matters(quarks,leptons and **W, Z**).² Here we call such intermediate clusters “**subquark**” and denote them as follows :

	<i>Y.M.representation</i>	<i>spin</i>	<i>e.m.charge</i>	
$\alpha = (\Lambda\Theta)$	$\alpha_L : (\bar{3}, 3, 1) \quad \alpha_R : (\bar{3}, 1, 3)$	$\frac{1}{2}$	$\frac{1}{3}e$	(8a)
$\beta = (\Lambda\bar{\Theta})$	$\beta_L : (1, 3, 1) \quad \beta_R : (1, 1, 3)$	$\frac{1}{2}$	0	(8b)
$\mathbf{x} = (\Lambda\Lambda, \Theta\Theta)$	$\mathbf{x}_L : (\bar{3}, 3, 1) \quad \mathbf{x}_R : (\bar{3}, 1, 3)$	0	$\frac{1}{3}e$	(8c)
$\mathbf{y} = (\Lambda\bar{\Lambda} \Theta\bar{\Theta})$	$\mathbf{y}_L : (1, 3, 1) \quad \mathbf{y}_R : (1, 1, 3)$	0	0,	(8d)

and there are also their antisubquarks[9].³

²Such thoughts have been proposed by Maki in Ref.[22]

³The notations of $\alpha, \beta, \mathbf{x}$ and \mathbf{y} are inherited from those in Ref.[9] written by Fritzsch and Mandelbaum, because ours is, in the subquark level, similar to theirs with two fermions and two bosons. R. Barbieri, R. Mohapatra and A. Masiero proposed the similar model[9].

Now we come to the step to build quarks and leptons. The gauge symmetry of the confining forces in this step is also $SU(2)_L \otimes SU(2)_R$ because the subquarks are in the triplet states of $SU(2)_{L,R}$ and then they are combined into singlet states by the decomposition of $3 \times 3 = 1 + 3 + 5$ in $SU(2)$. We make the first generation of quarks and leptons as follows :

	<i>e.m.charge</i>	<i>Y.M.representation</i>	
$\langle \mathbf{u}_h = \langle \alpha_h \mathbf{x}_h $	$\frac{2}{3}e$	$(3, 1, 1)$	(9a)
$\langle \mathbf{d}_h = \langle \bar{\alpha}_h \bar{\mathbf{x}}_h \mathbf{x}_h $	$-\frac{1}{3}e$	$(3, 1, 1)$	(9b)
$\langle \nu_h = \langle \alpha_h \bar{\mathbf{x}}_h $	0	$(1, 1, 1)$	(9c)
$\langle \mathbf{e}_h = \langle \bar{\alpha}_h \bar{\mathbf{x}}_h \bar{\mathbf{x}}_h $	$-e$	$(1, 1, 1),$	(9d)

where h stands for L (left handed) or R (right handed)[5].⁴ Here we note that β and \mathbf{y} do not appear. In practice $((\beta\mathbf{y}) : (1, 1, 1))$ -particle is a candidate for neutrino. But as Bjorken has pointed out[3], non-vanishing charge radius of neutrino is necessary for obtaining the correct low-energy effective weak interaction Lagrangian. Therefore β is assumed not to contribute to forming ordinary quarks and leptons. However $(\beta\mathbf{y})$ -particle may be a candidate for “sterile neutrino”. Presumably composite $(\beta\beta)$ -; $(\beta\bar{\beta})$ -; $(\bar{\beta}\bar{\beta})$ -states may go into the dark matters. It is also noticeable that in this model the leptons have finite color charge radius and then $SU(3)$ gluons interact directly with the leptons at energies of the order of, or larger than Λ_L or Λ_R [19].

Concerning the confinements of primons and subquarks, the confining forces of two steps are in the same spontaneously unbroken $SU(2)_L \otimes SU(2)_R$ gauge symmetry. It is known that the running coupling constant of the $SU(2)$ gauge theory satisfies the following equation :

$$\frac{1}{\alpha_W^a(Q_1^2)} = \frac{1}{\alpha_W^a(Q_2^2)} + b_2(a) \ln \left(\frac{Q_1^2}{Q_2^2} \right), \quad (10a)$$

$$b_2(a) = \frac{1}{4\pi} \left(\frac{22}{3} - \frac{2}{3} \cdot N_f - \frac{1}{12} \cdot N_s \right), \quad (10b)$$

where N_f and N_s are the numbers of fermions and scalars contributing to the vacuum polarizations, $(a = q)$ for the confinement of subquarks in quark and $(a = sq)$ for confinement of primons in subquark. We calculate $b_2(q) = 0.35$ which comes from that

⁴Subquark configurations in Eq.(9) are essentially the same as those in Ref.[5] written by Królikowski, who proposed the model of one fermion and one boson with the same e.m. charge $e/3$

the number of confined fermionic subquarks are 4 ($\alpha_i, i = 1, 2, 3$ for color freedom, β) and 4 for bosons (\mathbf{x}_i, \mathbf{y}) contributing to the vacuum polarization, and $b_2(sq) = 0.41$ which is calculated with three kinds of Λ and Θ owing to three color freedoms. Experimentary it is reported that $\Lambda_q > 1.8$ TeV(CDF exp.)[13] or $\Lambda_q > 2.4$ TeV(D0 exp.)[12]. Extrapolations of α_W^q and α_W^{sq} to near Plank scale are expected to converge to the same point and then tentatively, setting $\Lambda_q = 5$ TeV, $\alpha_W^q(\Lambda_q) = \alpha_W^{sq}(\Lambda_{sq}) = \infty$, we get $\Lambda_{sq} = 10^3 \Lambda_q$,

Next let us see the higher generations. Harari and Seiberg have stated that the orbital and radial excitations seem to have the wrong energy scale (order of $\Lambda_{L,R}$)[6,25] and then the most likely type of excitations is the system with the addition of $\mathbf{y}_{L,R}$ in Eq.(8d). In our model the essence of generation is like “*isotope*” in case of nucleus. Then using $\mathbf{y}_{L,R}$ we construct them as follows :

$$\begin{cases} \langle \mathbf{c} | = \langle \alpha \mathbf{x} \mathbf{y} | \\ \langle \mathbf{s} | = \langle \bar{\alpha} \mathbf{x} \mathbf{x} \mathbf{y} |, \end{cases} \quad \begin{cases} \langle \nu_\mu | = \langle \alpha \bar{\mathbf{x}} \mathbf{y} | \\ \langle \mu | = \langle \bar{\alpha} \mathbf{x} \mathbf{x} \mathbf{y} |, \end{cases} \quad \text{2nd generation (11a)}$$

$$\begin{cases} \langle \mathbf{t} | = \langle \alpha \mathbf{x} \mathbf{y} \mathbf{y} | \\ \langle \mathbf{b} | = \langle \bar{\alpha} \mathbf{x} \mathbf{x} \mathbf{y} \mathbf{y} |, \end{cases} \quad \begin{cases} \langle \nu_\tau | = \langle \alpha \bar{\mathbf{x}} \mathbf{y} \mathbf{y} | \\ \langle \tau | = \langle \bar{\alpha} \mathbf{x} \mathbf{x} \mathbf{y} \mathbf{y} |, \end{cases} \quad \text{3rd generation, (11b)}$$

where the suffix L, R s are omitted for brevity. We can also make vector and scalar particles with (1,1,1) :

$$\begin{cases} \langle \mathbf{W}^+ | = \langle \alpha^\dagger \alpha^\dagger \mathbf{x} | \\ \langle \mathbf{W}^- | = \langle \bar{\alpha}^\dagger \bar{\alpha}^\dagger \bar{\mathbf{x}} |, \end{cases} \quad \begin{cases} \langle \mathbf{Z}_1^0 | = \langle \alpha^\dagger \bar{\alpha}^\dagger | \\ \langle \mathbf{Z}_2^0 | = \langle \alpha^\dagger \bar{\alpha}^\dagger \mathbf{x} \bar{\mathbf{x}} |, \end{cases} \quad \text{Vector} \quad (12a)$$

$$\begin{cases} \langle \mathbf{S}^+ | = \langle \alpha^\dagger \alpha^\dagger \mathbf{x} | \\ \langle \mathbf{S}^- | = \langle \bar{\alpha}^\dagger \bar{\alpha}^\dagger \mathbf{x} |, \end{cases} \quad \begin{cases} \langle \mathbf{S}_1^0 | = \langle \alpha^\dagger \bar{\alpha}^\dagger | \\ \langle \mathbf{S}_2^0 | = \langle \alpha^\dagger \bar{\alpha}^\dagger \mathbf{x} \bar{\mathbf{x}} |, \end{cases} \quad \text{Scalar,} \quad (12b)$$

where the suffix L, R s are omitted for brevity and \uparrow, \downarrow indicate *spin up, spin down* states. They play the role of intermediate bosons same as π, ρ in the strong interactions. As Eq.(9) and Eq.(12) contain only α and \mathbf{x} subquarks, we can draw the “*line diagram*” of weak interactions as seen in Fig (1).

We know, phenomenologically, that this universe is mainly made of protons, electrons, neutrinos, antineutrinos and unknown dark matters. It is said that the universe contains almost the same number of protons and electrons. Our model show that one proton has the configuration of (**uud**) : $(2\alpha, \bar{\alpha}, 3\mathbf{x}, \bar{\mathbf{x}})$; electron: $(\bar{\alpha}, 2\bar{\mathbf{x}})$; neutrino: $(\alpha, \bar{\mathbf{x}})$; antineutrino: $(\bar{\alpha}, \mathbf{x})$ and the dark matters are presumably constructed from the same amount of matters and antimatters because of their neutral charges. Note that proton is a mixture of matters and anti-matters and **electron is composed of only anti-matters** . This may lead the thought that “**the Universe is the**

matter-antimatter-even object.” And then there exists a conception-leap between “proton-electron abundance” and “matter abundance” if our composite scenario is admitted (as for the possible way to realize the proton-electron excess universe, see Ref.[2]). This idea is different from the current thought that the Universe is made of matters only. Then the question about CP violation in the early universe does not occur in our model.

4 The mass of the scalar partner of Z^0

4.1 Hadronic meson

The masses of the vector mesons(denoted by $M(V)$) are found larger than the masses of their pseudo-scalar partners(denoted by $M(Ps)$)[24]. The mass differences between $M(V)$ and $M(Ps)$ are explained by the hyperfine spin-spin interaction in Breit-Fermi Hamiltonian by use of semi- relativistical approach[14].

The hyperfine interaction Hamiltonian(denoted by $H_{q\bar{q}}^l$) causing mass split between $M(V)$ and $M(Ps)$ is described as :

$$H_{q\bar{q}}^{l=0} = -\frac{8\pi}{3m_q m_{\bar{q}}} \vec{S}_q \cdot \vec{S}_{\bar{q}} \delta(|\vec{r}|), \quad (13)$$

where $\vec{S}_{q(\bar{q})}$ is a operator of $q(\bar{q})$'s spin with its eigenvalue of 1/2 or -1/2, $m_{q(\bar{q})}$ is quark (anti-quark) mass, l is the orbital angular momentum between q and \bar{q} and $|\vec{r}| = |\vec{r}_q - \vec{r}_{\bar{q}}|$ [14].

In QCD theory eight gluons are intermediate gauge bosons belonging to **8** representation which is real adjoint representation. Quarks(anti-quarks) belong to **3**($\bar{\mathbf{3}}$) representation which is complex fundamental representation. Therefore gluons can discriminate between quarks and anti-quarks and couple to them in the “*different sign*”. The strength of their couplings to different color quarks and anti-quarks is described as :

$$\begin{aligned} g \frac{\lambda_{ij}^a}{2} & : & \text{for} & \text{ quarks} \\ -g \frac{\lambda_{ij}^a}{2} & : & \text{for} & \text{ anti - quarks,} \end{aligned} \quad (14)$$

where $a(= 1 \sim 8)$: gluon indices; $i, j(= 1, 2, 3)$: quark indices; λ 's : SU(3) matrices and g : the coupling constant of gluons to quarks and anti-quarks(See Fig.(2)). The wave function of a color singlet $q\bar{q}$ (meson) system is $\delta_{ij}/\sqrt{3}$, corresponding to $|q\bar{q}\rangle =$

$(1/\sqrt{3})\sum_{i=1}^3|q_i\bar{q}_i\rangle$. By use of Eq.(14) the effective coupling for the $q\bar{q}$ system(denoted by α_s) is given by :

$$\begin{aligned}\alpha_s &= \sum_{a,b} \sum_{i,j,k,l} \frac{1}{\sqrt{3}} \delta_{ij} \left(\frac{g}{2} \lambda_{ik}^a \right) \left(-\frac{g}{2} \lambda_{lj}^b \right) \frac{1}{\sqrt{3}} \delta_{kl} = -\frac{g^2}{12} \sum_{a,b} \sum_{j,l} \lambda_{jl}^a \lambda_{lj}^b \\ &= -\frac{g^2}{12} \sum_{a,b} \text{Tr} \left(\lambda^a \lambda^b \right) = -\frac{g^2}{6} \sum_{ab} \delta_{ab} \\ &= -\frac{4}{3} g^2.\end{aligned}\tag{15}$$

Making use of Eq.(13) and Eq.(15) let us write the quasi-static Hamiltonian for a bound state of a quark and a anti-quark is given as :

$$H = H_0 + \alpha_s H_{q\bar{q}}^{l=0}.\tag{16}$$

Calculating the eigenvalue of H in Eq.(16) we have :

$$M(V \text{ or } S) = M_0 + \xi_q < \vec{S}_q \vec{S}_{\bar{q}} >,\tag{17}$$

where ξ_q is a positive constant which includes the calculation of α_s . In Eq.(17) it is found that $< \vec{S}_q \vec{S}_{\bar{q}} > = -3/4$ for pseudoscalar mesons and $< \vec{S}_q \vec{S}_{\bar{q}} > = 1/4$ for vector mesons and then we have :

$$\begin{aligned}M(P_s) &= M_0 - \frac{3}{4} \xi_q \\ M(V) &= M_0 + \frac{1}{4} \xi_q.\end{aligned}\tag{18}$$

Eq.(18) results that :

$$M(V) > M(P_s).\tag{19}$$

Here let us define :

$$\begin{aligned}\tilde{M} &= \frac{1}{2} (M(V) + M(P_s)), \\ \Delta &= M(V) - M(P_s), \\ R &= \frac{\Delta}{\tilde{M}}.\end{aligned}\tag{20}$$

Using Eq(20) and data of [24] We have :

$$\begin{aligned}R &= 1.4 && \text{for } \rho - \pi \\ R &= 0.35 && \text{for } \omega - \eta\end{aligned}$$

$$\begin{aligned}
R &= 0.58 & \text{for } K^* - K \\
R &= 0.6 & \text{for } \phi - \eta \\
R &= 0.04 & \text{for } J/\Psi - \eta_c
\end{aligned} \tag{21}$$

4.2 Weak boson

Here let us turn discussions to “intermediate-weak-bosons”. As seen in Eq.(12a,b) Z^0 weak boson has its scalar partner S^0 and both of them contain “*fermionic*” α_L and $\bar{\alpha}_L$ as subquark elements. Referring Eq.(8a) we find that both of α_L and $\bar{\alpha}_L$ belong to “adjoint **3**” state of $SU(2)_L$ (which is the real representation) and then $SU(2)_L$ -hypercolor gluons cannot distinguish α_L from $\bar{\alpha}_L$. Therefore the hypercolor gluons couple to α_L and $\bar{\alpha}_L$ in the “*same sign*”. This point is distinguishably different from hadronic mesons (Refer Eq.(14)). The wave function of a hypercolor singlet ($\alpha\bar{\alpha}$)-system is $\delta_{ij}/\sqrt{3}$, corresponding to $|\alpha_i\bar{\alpha}_i\rangle = (1/\sqrt{3})|\sum_{i=1}^3|\alpha_i\bar{\alpha}_i\rangle$ where $i = 1, 2, 3$ are different three states of the triplet of $SU(2)_L$.

The strength of their couplings to different hypercolor subquarks and anti-subquarks is described as :

$$\begin{aligned}
g_h \frac{\tau_{ij}^a}{2} & : & \text{for subquark} \\
g_h \frac{\tau_{ij}^a}{2} & : & \text{for anti-subquark,}
\end{aligned} \tag{22}$$

where $a(= 1, 2, 3)$: hypercolor gluon indices; $i, j(= 1, 2, 3)$: subquark and anti-subquark indices and τ : $SU(2)$ matrices and g_h : the coupling constant of hypergluons to the subquarks and anti-subquarks (See Fig.(2)). By use of Eq.(20) the effective coupling (denoted by α_W) is given by :

$$\begin{aligned}
\alpha_W &= \sum_{a,b} \sum_{i,j,k,l} \frac{1}{\sqrt{3}} \delta_{ij} \left(\frac{g_h}{2} \tau_{ik}^a \right) \left(\frac{g_h}{2} \tau_{lj}^b \right) \frac{1}{\sqrt{3}} \delta_{kl} = \frac{g_h^2}{12} \sum_{a,b} \sum_{j,l} \tau_{jl}^a \tau_{lj}^b \\
&= \frac{g_h^2}{12} \sum_{a,b} \text{Tr}(\tau^a \tau^b) = \frac{g_h^2}{6} \sum_{ab} \delta_{ab} \\
&= \frac{1}{2} g_h^2,
\end{aligned} \tag{23}$$

where $a, b = 1, 2, 3$; $i, j, k, l = 1, 2, 3$.

Note that α_s (in Eq.(15)) is “*negative*” and α_W (in Eq.(23)) “*positive*”. Through

the same procedure as hadronic mesons the masses of Z^0 and S^0 are described as :

$$M(Z^0 \text{ or } S^0) = M_0 - \xi_{sq} < \vec{S}_\alpha \vec{S}_{\bar{\alpha}} >, \quad (24)$$

where ξ_{sq} is a positive constant which includes the calculation of α_W and $\vec{S}_{\alpha(\bar{\alpha})}$ is the spin operator of $\alpha(\bar{\alpha})$. In Eq.(24) it is calculated that $< \vec{S}_\alpha \vec{S}_{\bar{\alpha}} > = -3/4$ for scalar : S^0 and $< \vec{S}_\alpha \vec{S}_{\bar{\alpha}} > = 1/4$ for vector : Z^0 and then we get :

$$\begin{aligned} M(S^0) &= M_0 + \frac{3}{4}\xi_{sq} \\ M(Z^0) &= M_0 - \frac{1}{4}\xi_{sq}. \end{aligned} \quad (25)$$

From this it follows that :

$$M(S^0) > M(Z^0). \quad (26)$$

Here let us define :

$$\begin{aligned} \tilde{M}_W &= \frac{1}{2} (M(S^0) + M(Z^0)), \\ \Delta_W &= M(S^0) - M(Z^0), \\ R_W &= \frac{\Delta}{\tilde{M}}. \end{aligned} \quad (27)$$

If we adopt $M(Z^0) = 91$ GeV and $M(S^0) = 125$ GeV, we obtain :

$$R_W = 0.3, \quad (28)$$

which is compared with Eq(21).

Lastly from Eq(12a) it is expected that there exist “**Charged Higgs-Bosons**” as scalar partners of W^\pm and they may be found around 100 to 120 GeV.

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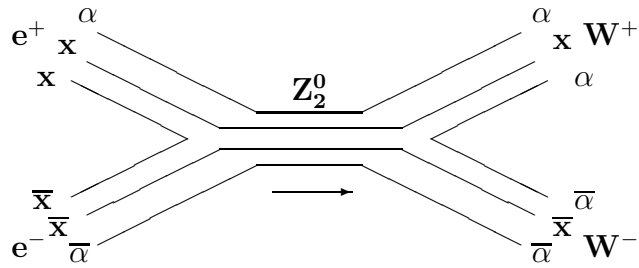
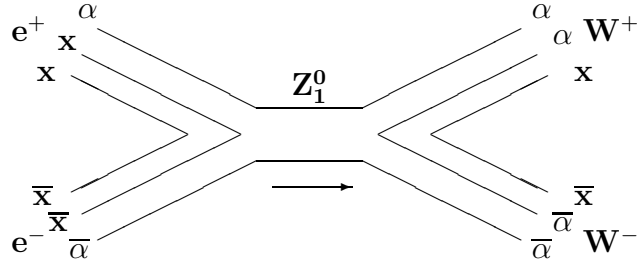
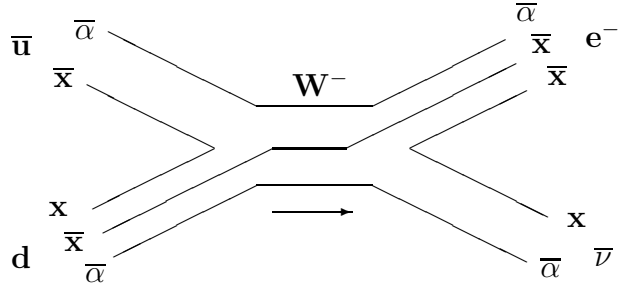


Figure 1: Subquark-line diagrams of the weak interactions

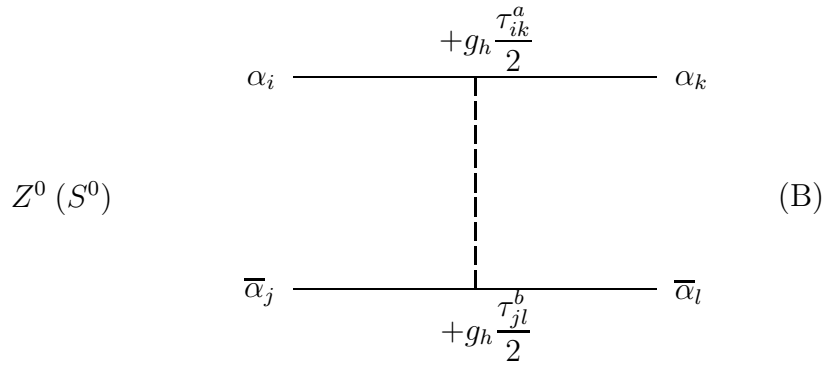
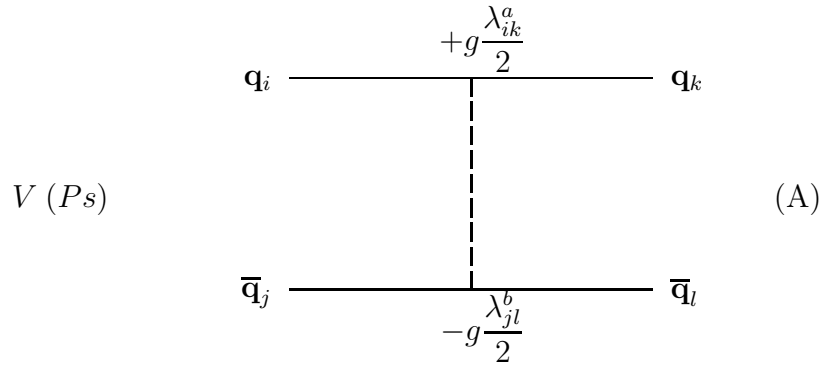


Figure 2: (A) Gluon exchange in $\mathbf{q}\bar{\mathbf{q}}$ system; (B) Hypergluon exchange in $\alpha\bar{\alpha}$ system.